Space Weather Technical Forecast

Issued on Wednesday 9 October 2024 at 01:21 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of X-class flares. Chance of S1 Minor Solar Radiation Storm. Chance of G1-G2 Minor/Moderate Storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Has been Moderate, starting the previous 24 hours at M2.71 level, due to the declining trend from the X1.0 flare at 07/2059 UTC, which was probably associated with previous region AR3844. Low level M-class flares followed through the day from various regions on the visible disc. There are currently five numbered regions on the disc, with the addition of a very small and simple region which has recently emerged in the northeast quadrant. AR3842 and AR3849, possibly AR3850, are now the most active regions on the disc, the sources of minor M-class flares. AR3942 remains magnetically complex with a delta spot, while three other regions have moderately complex beta-gamma configurations.

A large filament eruption was seen to have left the Sun early on 08 Oct, it appears to be directed mainly south, but a weak glancing blow from the associated CME is possible on the 11th.

Solar Wind / Geomagnetic Activity: The period started with residual CME influence, possibly from the glancing influence of the 04 Oct CME. The onset of a weak coronal hole high speed stream from CH78 also potentially occurred. Solar wind speed remained slightly elevated, mainly between 400-470km/s, with density varying between below average and average values. Interplanetary Magnetic Field, Bt, was initially Strong at 15-16 nT, but then declined to Moderate levels, ending the day 9-10 nT. The north-south component, Bz, favoured a negative (southward) orientation with only brief spells of positive (northward), and was also initially Strong reaching -16 nT, then declining to end the period weakly negative around -2 to -5 nT. Phi angle was positive (away from the Sun). Geomagnetic activity started at G3/Strong geomagnetic storm levels (Kp 7) between 08/0000-0600 UTC. Activity then decreased to end the day at Quiet levels (Kp 2).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 was initially slightly raised, reaching 2 pfu at 08/0445 UTC, but then decreased to background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at predominantly at background levels, but temporarily reached Moderate levels of 138 pfu at 08/1700 UTC. The associated 24-hour fluence was below the Active threshold with 1.16e6 observed at 09/0000UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is expected, with a chance of isolated X-class flares until day 2 (10 Oct). From day 3 (11 Oct) activity is then expected to decrease Low to Moderate, but with a slight chance of X-class flares. However, new or returning regions are likely to rotate onto the visible disc through the period, therefore potentially increasing activity again.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs currently feature in the forecast. However, there are potential glancing CMEs. The solar wind environment around Earth is slightly disturbed at first, due to residual CME influences and possibly a weak high speed stream from CH78/+. Solar wind speeds are expected to start at slightly elevated levels, with a slight chance of becoming temporarily enhanced during days 2 or 3 should any glancing CME impacts occur. Later in the period winds are expected to decrease to background levels.

Geomagnetic activity is expected to be Active to G1/Minor Storm (Kp 4-5) initially. Activity will then decline, becoming predominantly Quiet to Unsettled for the rest of the period, but with a chance of G1/Minor Storms during days 2 and 3 (10th and 11th). However, any CME glancing impacts will bring a chance of G1-G2 Minor to Moderate storms.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 responded erratically to the two X-class flares from late on 07 Oct, with proton levels remaining below the S1 Minor radiation storm level. There is a chance of reaching S1 proton levels today and tomorrow, then decreasing to a slight chance by the end of the period. High energy electron flux is expected to gradually rise through the period, albeit with the typical diurnal oscillation, reaching predominantly moderate levels. The associated 24 hour election fluence is therefore expected to respond with a gradual increase, whilst remaining below the Active threshold (1e8 total pfu).

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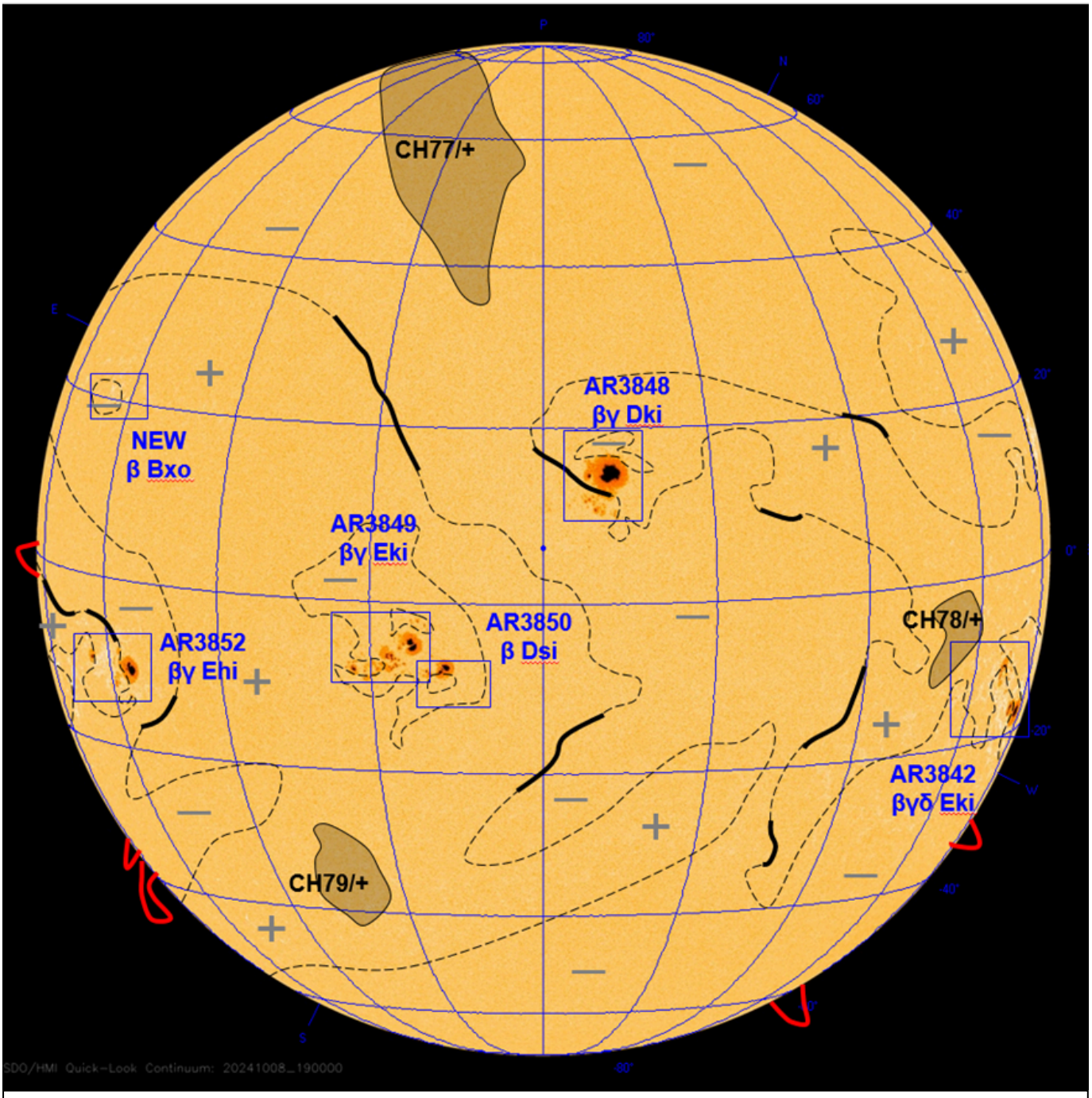
Figure 1: Synoptic map 08/1900 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

No further Earth-directed CMEs currently feature in the forecast. The large and bright CMEs evident from the X2.1 and X1.0 flares are expected to miss Earth but may have an outside chance of glancing impacts, perhaps on days 2 or 3 (10 or 11 Oct). A large filament eruption was also seen to leave the Sun early on 08 Oct, it appears to be mostly south directed, but a weak glancing blow from the associated CME is possible on the 11th.

The solar wind environment around Earth remains slightly disturbed at first, due to residual CME influences and possibly a weak high speed stream from CH78/+. Solar wind speeds are likely to start at slightly elevated, then excluding any CME enhancements, decrease to background speeds within the next 4 days. Should any CME glancing interactions occur on days 2 or 3 (10-11 Oct) solar wind speeds may become enhanced for for a time.

Geomagnetic activity is expected to be Active to G1/Minor Storm (Kp 4-5) initially. Activity will then decline, becoming predominantly Quiet to Unsettled for the rest of the period, but with a chance of G1/Minor Storms during days 2 and 3 (10th and 11th). However, any CME glancing impacts will bring a chance of G1-G2 Minor to Moderate storms.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	Yes	70	30	20	20
Strong	**G3**	Yes	20	5	2	2
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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Figure 2: Latest MOSWOC Enlil.

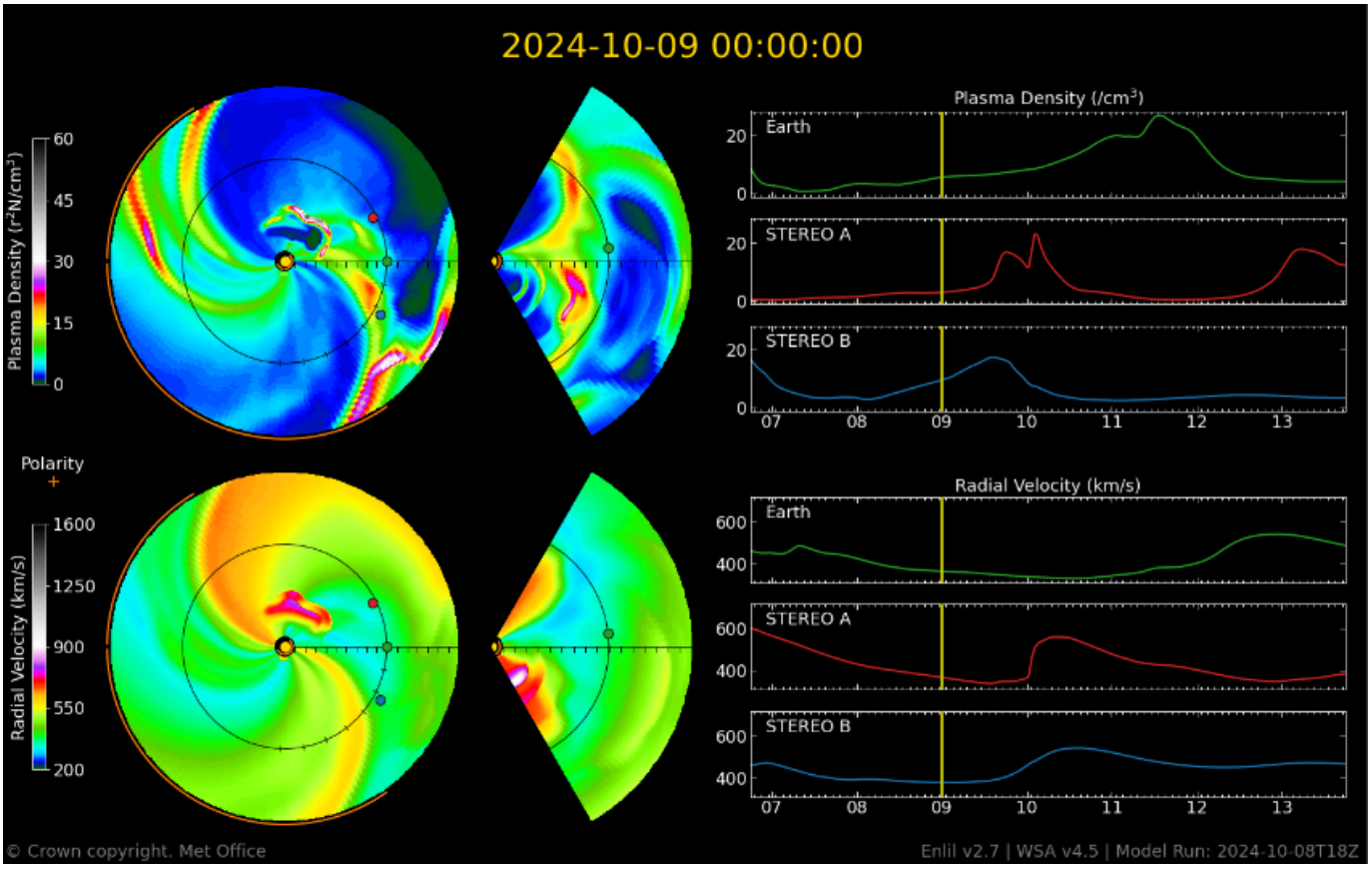

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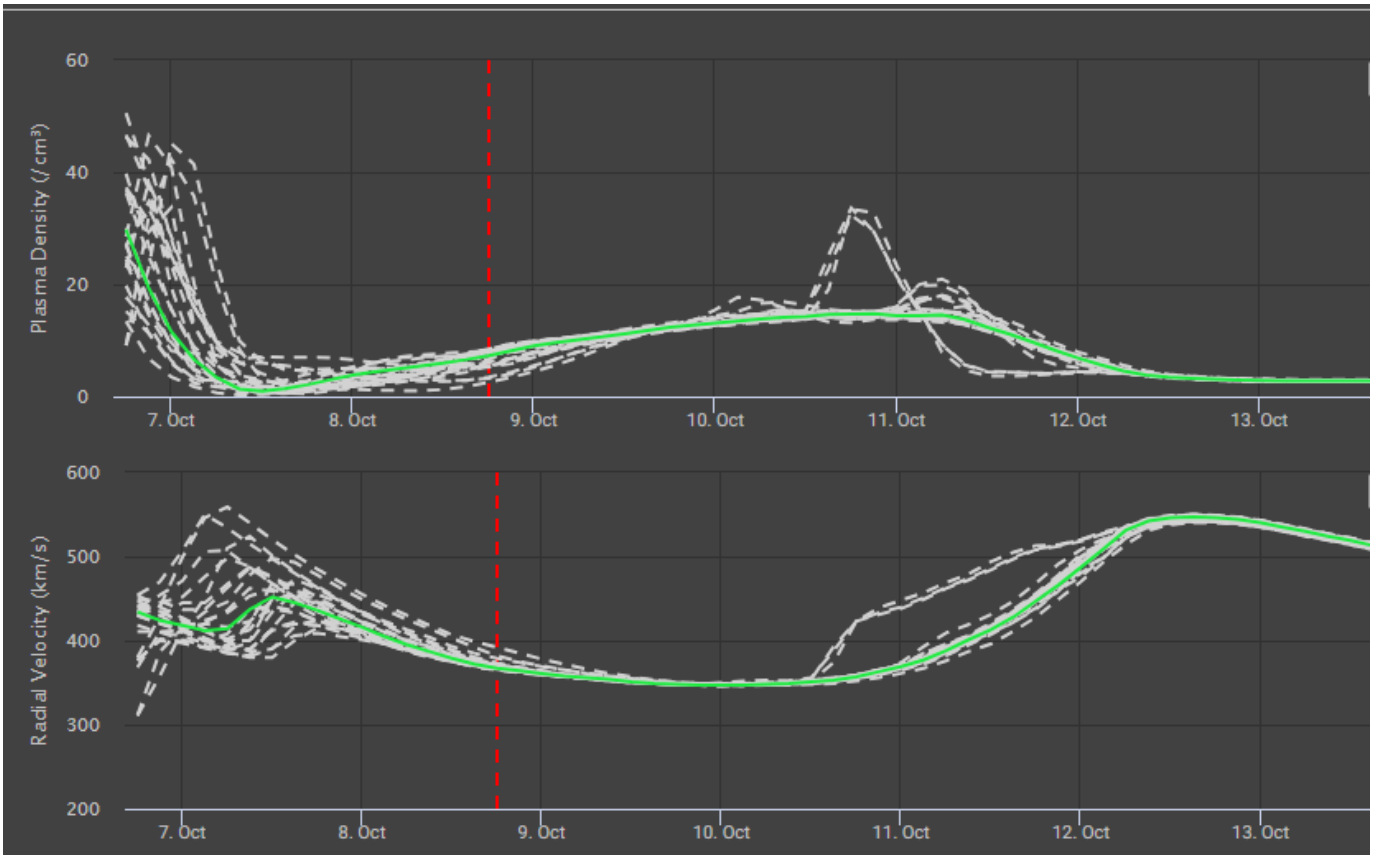
Figure 3: MOSWOC Enlil ensembles



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Radio Blackouts - X-Ray Flares

There are now five numbered sunspot regions visible. AR3842 appears to have reduced slightly in area, while maintaining a strong delta spot and so complex magnetic structure. However, the apparent slight decay in AR3842 may be due to its position, and therefore viewing angle, approaching the southwest limb. AR3848 in the north-centre has a very large mature positive leader, with numerous small trailing spots and weak penumbra surrounding them, maintaining the beta-gamma classification. The region is close to developing multiple small and weak delta spots, if the surrounding penumbra consolidates and connects to the penumbra of the main spot. AR3849 and AR3850 remain very close to each other. AR3849 has shown some slight decay in trailing spots to the south of the main leader spot, while small intermediate spots have developed to the north of the main spot, and is now classified as Eki/beta-gamma. AR3850 has shown slight decay in area, with penumbra reducing around some small trailing spots. AR3852 in the southeast appears to have slightly reduced in area, with a small decay in penumbra around intermediate spots.

Activity has been at Moderate levels with occasional low level M-class flares. Further M-flares are expected, with on ongoing chance of a isolated X-class flares, mainly from previous region AR3844 which is now behind the west limb. The proton flux remains at background levels, but any further notable flare activity brings a chance of S1 Minor proton storms.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	80	80	70	50
Very Active	R3-R5 (X Class)	No	30	30	20	10

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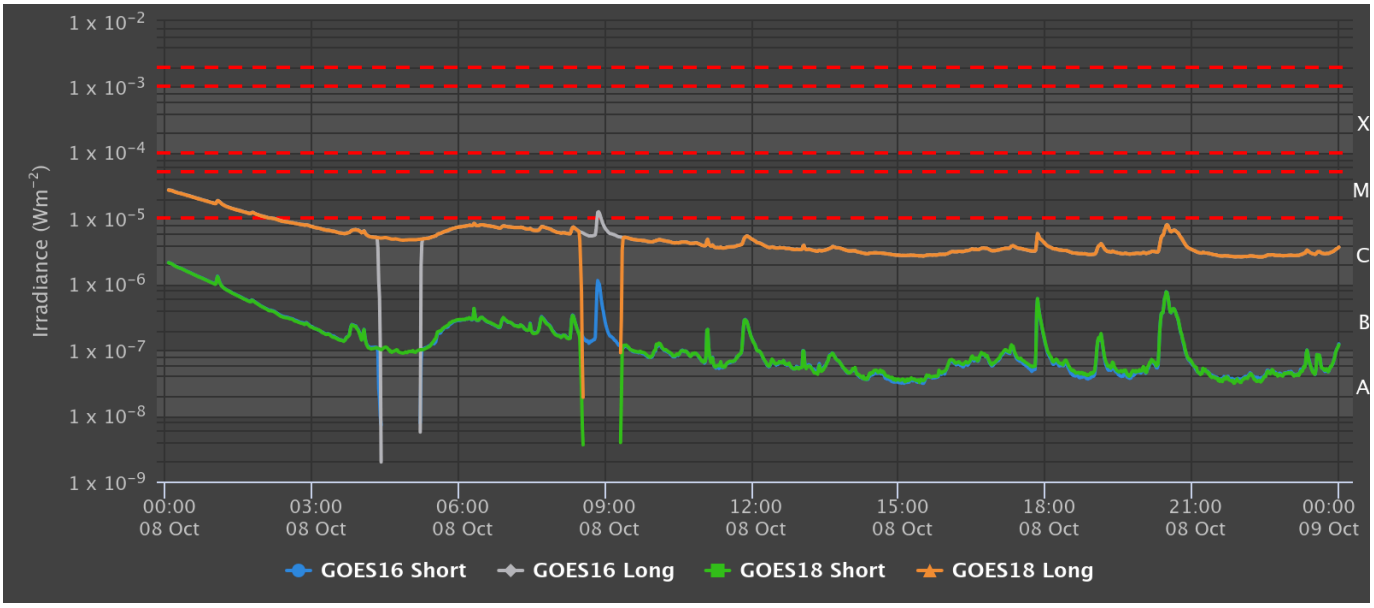
Figure 4: Last 24 hours X-ray flux, showing the trailing portion of the earlier X1.0 flare on the 7th.



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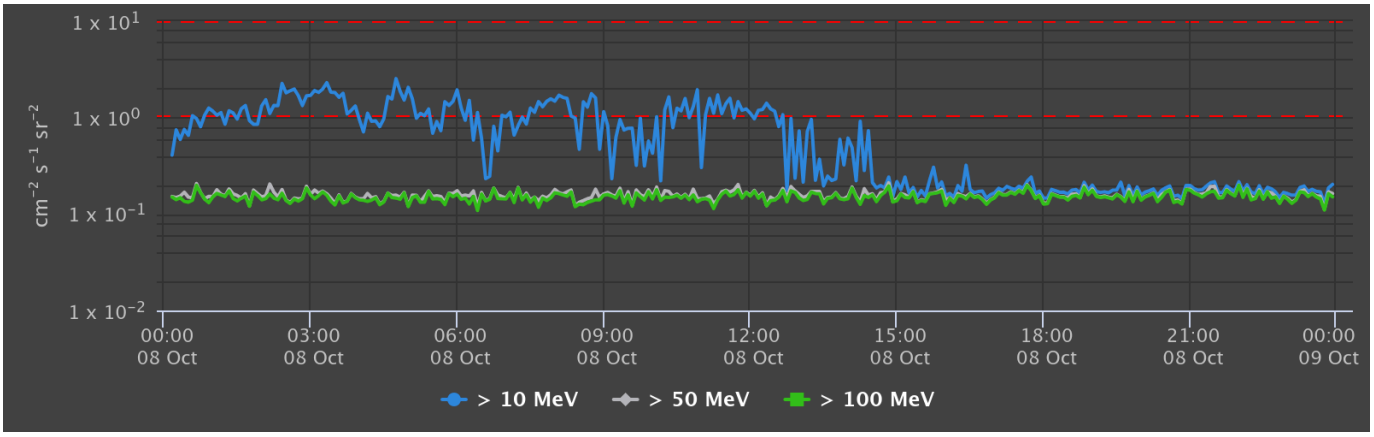
Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES18 responded erratically to the X2.1 and X1.0 flares that occurred late on 07 Oct, with proton levels remaining below the S1 Minor radiation storm level. There is a chance of reaching S1 proton levels today while AR3842 remains on the visible disc, and tomorrow with AR3842 rotating behind the west limb. The chance of reaching S1 proton levels then decreases to a slight chance by the end of the period, with the other regions on the disc currently relatively inactive.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	40	20	10	10
Very Active	**≥ S3 ***	No	1	1	1	5
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: GOES 18 Proton Flux for the past 24 hours.



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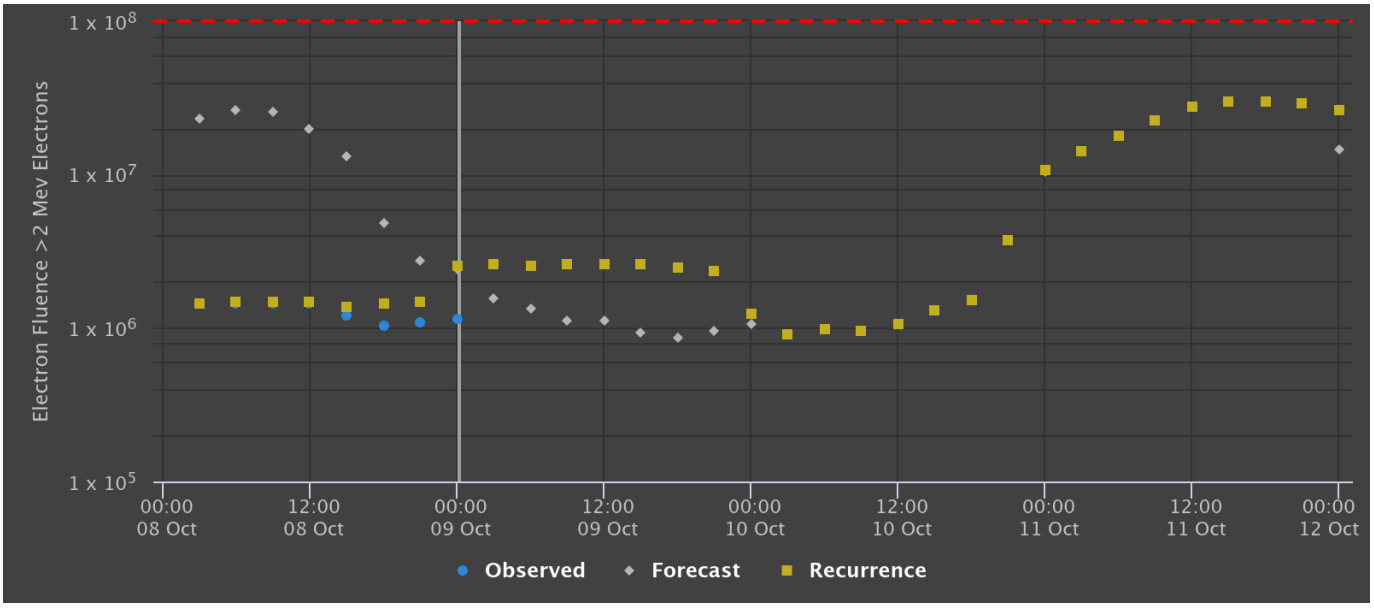
High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2MeV) observed by GOES16 has been at background levels, likely suppressed due to ongoing residual solar wind enhancements from the CME and weak coronal hole fast winds from CH78/+. The combination of both may have increased electron populations at lower orbits. Therefore, as solar wind pressure subsides and the Van Allen belts return outward, flux is expected to rise at GEO. This is likely to result in Moderate levels from day 2 (10 Oct), and perhaps temporary High levels later in the forecast period at the peak of the diurnal cycle.

The associated 24 hour fluence is expected to persist below the Active (1e8 total pfu) threshold, but with a rising trend later in the period. This rising trend is supported by REFM.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	10	20	40
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 6: MOSWOC REFM model.



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